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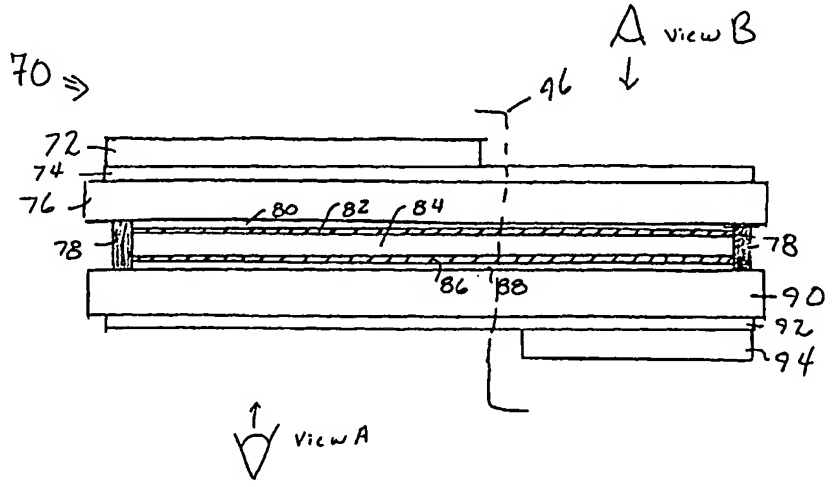

(57) Abstract

A liquid crystal display (70) creates two viewing areas (view A and view B) which are visible from opposite sides of the display. The liquid crystal display comprises a first light layer (72), which reflects or emits light to create a display for a first view. The first layer (72) is adjacent to a first surface of a series of intervening liquid crystal display layers (74, 76, 80, 82, 84, 86, 88, 90, 92) which perform additional functions to create the display for the first view and for a second view. The first light layer only partially covers the series of intervening liquid crystal display layers. The liquid crystal display also comprises a second light layer (94) adjacent to a second surface of the series of intervening liquid crystal display layers. The second light layer (94) is positioned so as to create a display for the second view which is not blocked by the first light layer (72). The second light layer (94) only partially covers the second surface of the series of intervening liquid crystal display layers so as not to block the display created for the first view.

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DUAL VIEW LCD ASSEMBLY

BACKGROUND OF THE INVENTION

I. Field of the Invention

The invention relates to electronic displays. More particularly, the invention relates to liquid crystal displays.

II. Description of the Related Art

Liquid crystal displays (LCD) are used to provide a visual user interface for electronic equipment. LCDs dominate the portable display market because they consume a reasonably small amount of power while providing an aesthetically pleasing means of providing information to a user. In addition, LCDs are small in size, light in weight, durable and inexpensive.

Figure 1 is a cross-sectional view of a typical LCD assembly. The liquid crystal fluid 20 is the active medium which is used to create the viewing image. The liquid crystal fluid 20 is confined within a reservoir. The liquid crystal fluid 20 consists of a very large number of elongated crystals suspended in a fluid. The reservoir which holds the liquid crystal fluid 20 is sandwiched between two aligning layers 30.

The aligning layers 30 are sandwiched between a front transparent electrode 28A and a rear transparent electrode 28B. Together, the aligning layers 30 and the front and rear transparent electrodes 28 are used to impress an electronic field upon the liquid crystal fluid 20 in the reservoir. The reservoir is closed by the seals 32. The reservoir assembly is sandwiched between two thin sheets of glass 22A and 22B. A front polarizer 24A is bonded to the outside surface of the front glass sheet 22A. A rear polarizer 24B is bonded to the glass sheet 22B. A reflector 26 is bonded to the rear polarizer 24B.

As incident light of random polarization strikes the front polarizer 24A, only that portion of the incident light which is polarized in the same

manner as the front polarizer 24A passes through the front polarizer. The remainder of the incident light is reflected or absorbed. The polarized light passes through the glass sheet 22A, the front transparent electrode 28A and the front aligning layer 30A. The polarized light then strikes the liquid crystal fluid 20 in the reservoir. When no electric field is applied to the liquid crystal fluid 20, the polarization of the light is changed as it passes through the spiraling crystals of the liquid crystal fluid 20. The light then passes through the rear aligning layer 30B and the rear transparent electrode 28B and the rear glass sheet 22B. The rear polarizer 24B has a polarization which is aligned opposite to the polarization of the front polarizer 24A. In general, if two polarizers having opposite polarization are stacked one upon the other, no light passes through both layers because only the light with the polarization of the top layer reaches the rear layer and none of that light passes through the rear polarizer because it is polarized in the opposite direction. However, in this case, the spiraling crystals in the liquid crystal fluid have randomized the polarization of the light which strikes the rear polarizer 24B. The light which is aligned with the rear polarizer 24B passes through the rear polarizer 24B and strikes the reflector 26. The light follows the corresponding reverse path back through the liquid crystal display elements. In this way, a transparent path through the assembly is provided and the viewer sees the light colored surface of the reflector 26.

The function of the front transparent electrode 28A and the rear transparent electrode 28B is to impress an electric field on the liquid crystal fluid 20. When an electric field is applied, the spiraling crystals in the liquid crystal fluid 20 untwist and align themselves with the field. The polarized light which passes through the aligned liquid crystal fluid 20 is not twisted and randomized but passes through retaining its original polarization. Thus, the light which strikes the rear polarizer 24B is out of phase with polarization of the rear polarizer 24B and does not pass through but is absorbed. In the absence of the reflected light, the display looks dark or opaque. By selectively applying the electric field in a desired pattern, an image can be created on the liquid crystal display.

In the embodiment shown in Figure 1, the liquid crystal display operates based upon ambient light. However, to make the screen visible in the absence of sufficient ambient light, liquid crystal displays have been developed which use transmissive, reflective and transflective light. For example, Figures 2A, 2B and 2C show three different types of liquid crystal displays. Figure 2A shows a reflective design such as the one shown in Figure 1. In Figure 2A, the reflector 26 reflects ambient light in order to create an image. Figure 2B shows a transflective liquid crystal display. In a transflective liquid crystal display, the reflector 26 is replaced with a transflector 42. As the name implies, the transflector is partially transmissive and partially reflective allowing a back-lit display to be visible in any lighting conditions. The transmissive liquid crystal display shown in Figure 2C uses neither a reflector nor a transflector and allows backlighting to shine through unattenuated as depicted and can be used in environments which are dimly lit. The transflective liquid crystal display such as the one shown in Figure 2B is by far the most popular because with the addition of a back-light, the LCD can create a display which is visible in many lighting conditions from very bright to very dark.

One critical feature of selecting the proper liquid crystal display for a given environment is the type of backlighting used. If the ambient light is dim or non-existent, some means of artificial light must be provided. This can be accomplished, for example, by the use of an electroluminescent panel, a light-emitting diode array or a cold cathode fluorescent lamp. Electroluminescent backlight uses a thin panel which, when excited by an A.C. voltage at about 80 volts and about 400 hertz, glows with a soft, even light. Typically, a D.C. to A.C. converter is used to obtain the A.C. driving voltage from a 3.6, 5 or 12 volt battery source. Electroluminescent back-lit panels are available in a variety of colors. Electroluminescence is the most efficient of the three common types of backlighting and, therefore, it is commonly used with battery operated applications.

In a light-emitting diode array liquid crystal display, a series of light-emitting diodes are arranged either along the edge of or behind a diffuser to provide a bright, even backlight to the display. Typically, the light-emitting

diodes are powered from a 5 volt power supply through a series of current limiting resistors. Light-emitting diode LCDs are moderately bright and very long lasting and are popular backlighting for small to medium-size displays. They typically consume more power than electroluminescent backlighting but are brighter. When the cost of the converter is considered, they can be more economical than electroluminescent backlighting. Light emitting diode backlights are available in a variety of colors with yellow-green being one of the most popular.

Cold cathode fluorescent lamp backlighting can provide moderately bright illumination over a large area and is the most common light source used with large panel displays. This type of backlighting can provide a paper white color and, therefore, can be used with color displays. Cold cathode fluorescent lamps require a high-voltage, high-frequency source of power so they typically also require the use of a D.C. to A.C. converter.

In general, a liquid crystal display module consists of a printed circuit card which supports and connects surface mount integrated circuits and other electronic components associated with driving the display. The rear glass sheet has metallic contacts around the periphery of the bottom surface. An elastomer connector can be used to provide an electrical connection between the rear glass sheet and the plated metal contacts on the printed circuit board. A metal bezel can be used to hold the rear sheet of glass in contact with the elastomeric connector and the printed circuit board. The backlight diffuser, if used, can be placed between the printed circuit board and the rear sheet of glass.

As noted above, LCDs are extremely common in many types of electronic devices. For example, Figure 3 shows a portable folding phone 50. The portable folding phone 50 comprises an LCD assembly 52 such as those just discussed. When a folding lid 62 is opened, the LCD assembly 52 is visible through an LCD window 54. The folding phone 50 also comprises a keypad 56 which the user touches to enter information such as telephone numbers into the folding phone 50. Beneath the keypad 56 are keypad switches 58 which detect the depression of the keypad 56 keys. Beneath the keypad switches 58, a circuit card 60 comprises the integrated circuits and

other electronic components necessary to operate the folding phone 50. For example, in addition to the circuits necessary to establish wireless communications, the circuit card 60 comprises the LCD driver as well as by-pass capacitors and any special power supply components needed to operate the LCD assembly 52.

The LCD assembly 52 can be used to provide information to the user. For example, it can be used to provide feedback information concerning the entries received through the keypad 56 from the user. It can be used to provide information as to stored numbers and functions. In addition, it can provide an indication of the identity of an incoming call, such as a caller ID, if such information is available. In a typical configuration, the portable folding phone 50 rings upon detection of incoming calls even when the folding lid 62 is closed. In order to ease the answering process, in some embodiments, opening the folding lid 62 when an incoming call is ringing answers the call. Thus, unless the folding lid 62 comprises a window through which the LCD assembly 62 is visible, the user is unable to examine any caller ID information available on the LCD assembly 62 before the call is answered. Because the user can be charged for incoming calls, it can be important to the user to know the identity of the calling party before accepting the call.

Phone designs including a window in the folding lid 62 through which the LCD assembly is visible are not always optimal and, based upon the organization of the other phone components, may not be possible to provide in some phone designs. In the configuration shown in Figure 3, the majority of the circuit elements are located in the bottom portion of the folding phone 50. However, in many embodiments, the folding lid 62 comprises a substantial portion of the electronics which are used to operate the phone. For example, in some folding phone designs, each of the hinged portions of the phone comprise a circuit board such as those necessary to operate an ear-piece speaker and to operate a mouthpiece microphone. Accordingly, in such a design, it is not optimal and, in fact, may not be reasonably possible to provide a window through the covering portion of the flip lid 62.

In one embodiment, the LCD assembly may be moved to the backside of the phone so that it is visible when the folding lid is closed. In order for the LCD assembly to provide feedback information to the user, it is advantageous to have the LCD mounted on the same side of the phone as the keypad. However, it is not desirable to mount the keypad on the external surface of the phone because of the harsh environment which it may be subjected to and because the keys may be inadvertently depressed.

In another embodiment, two separate LCD assemblies may be provided: one which is visible when the folding lid is open and one which is visible when the folding lid is closed. However, inclusion of two LCD assemblies requires the inclusion of two LCD driver integrated circuits including by-pass capacitors and the inclusion of two mounting means as well as additional driving software. Therefore, inclusion of two LCD assemblies may not be practical. Therefore, there has been a need in the industry to provide a method and apparatus for a more versatile LCD which overcomes the limitations of the prior art.

SUMMARY OF THE INVENTION

A liquid crystal display creates two viewing areas which are visible from opposite sides of the display. The liquid crystal display comprises a first light layer which reflects or emits light to create a display for a first view. The first light layer is adjacent to a first surface of a series of intervening liquid crystal display elements which perform additional functions to create the display for the first view and for a second view. The first light layer only partially covers the series of intervening liquid crystal display element.

The liquid crystal display also comprises a second light layer adjacent to a second surface of the series of intervening liquid crystal display element. The second light layer is positioned so as to create a display for the second view which is not blocked by the first light layer. The second light layer only partially covers the second surface of the series of intervening liquid crystal display elements so as not to block the display created for the first view.

In one embodiment, the liquid crystal display is mounted within a housing having windows on opposite sides so that the first and second views are visible from first and second sides of the housing, respectively. In another embodiment, the liquid crystal display is controlled and powered by a single set of driving components.

BRIEF DESCRIPTION OF THE DRAWINGS

The features, objectives, and advantages of the invention will become more apparent from the detailed description set forth below when taken in conjunction with the drawings:

Figure 1 is a cross-sectional view of a typical LCD assembly.

Figures 2A, 2B and 2C are cross-sectional views illustrating LCDs comprising a reflective, transmissive and transflective light layer.

Figure 3 is a assembly drawing of a portable folding phone.

Figure 4 is a cross-sectional view showing a dual view LCD assembly according to the invention.

Figure 5 is a assembly drawing of a portable folding phone comprising a dual view LCD assembly according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

Providing an efficient and effective visual display is an important factor in designing an electronic device which provides the performance necessary for commercial success. While the aesthetic nature and the practical purpose of the display are important, it is also important that the display operate efficiently on the available power resources and that it occupy a reasonable amount of space including mounting structures and driving components. The dual view liquid crystal display assembly described below elegantly addresses these factors in cases where it is advantageous to provide a display on two opposite sides of a device.

Figure 4 is a cross-sectional view showing a dual view LCD assembly according to the invention. The dual view LCD assembly 70 operates in accordance with common LCD technologies while providing a new dual view

feature. As noted by the view A and view B indications on Figure 4, the dual view LCD assembly 70 provides a visible display from the two display surfaces. The LCD assembly 70 is comprised of a series of layers pictured horizontally in Figure 4.

A view A reflector 72 reflects ambient light. In an alternative embodiment, backlighting is used according to standard means available in the industry. Relative to view A, in front of the view A reflector 72 is a polarizer 74. The polarizer 74 continues past the edge of the view A reflector 72 such that it acts as the rear polarizer for view A while acting as the front polarizer for view B. In this way, the view A reflector 72 only partially covers the polarizer 74. A sheet of glass 76 also extends past the edge of the view A reflector 72 such that the sheet of glass 76 acts as the rear glass sheet for view A while acting as the front glass sheet for view B. The seals 78 are used to create a reservoir for the liquid crystal fluid 84. The liquid crystal fluid 84 functions in a similar manner for both view A and view B. A transparent electrode 80 extends past the edge of the view A reflector 72 so that it acts as the rear transparent electrode for view A while acting as the front transparent electrode for view B. In a similar manner, the aligning layer 82 acts as the rear aligning layer for view A while acting as the front aligning layer for view B.

Continuing in a symmetrical manner, an aligning layer 86 operates as the front aligning layer for view A while acting as the rear aligning layer for view B. A transparent electrode 88 acts as the front transparent electrode for view A and the rear transparent electrode for view B. A sheet of glass 90 acts as the front sheet of glass for the view A and as the rear sheet of glass for the view B. A polarizer 92 acts as the front polarizer for view A and the rear polarizer for view B. A view B reflector 94 reflects natural light to provide a visible display to view B. The view B reflector 94 does not cover the entire polarizer 92 such that it does not block the display provided to view A. In an alternative embodiment, the reflector 94 may be replaced with an element which provides backlighting according to well-known techniques.

Thus, a dual view LCD assembly is created such that the reflector 72 provides a display to view A and the reflector 94 provides a display to view B. As shown in Figure 4, a median line 96 which perpendicularly bisects the dual

view LCD assembly 70 can be chosen such that it intersects neither the reflector 72 nor the reflector 94. In other embodiments, the median line may intersect both the view A reflector 72 and the view B reflector 94. In yet another embodiment, the edge of the view A reflector 72 and the edge of the view B reflector 94 may each align themselves with a median line. In other embodiments, the view A and view B reflector light layers may be irregularly shaped or even discontinuous. In the general embodiment, a first reflector or artificial light source is disposed on one surface of the intervening LCD layers and a second reflected or artificial light layer is disposed on the other surface of intervening LCD elements, such as, for example, the layers described above, so that each of the reflectors or artificial light sources act to provide a light to one of two distinct views of the display. The size and relative placement of the reflectors or artificial light sources depend upon the application in which the dual view LCD assembly will be used.

Figure 5 is a diagram showing a portable folding phone 98 comprising a dual view LCD assembly 70 according to the invention. In the embodiment shown in Figure 5, the LCD assembly is mounted within a first housing portion 95 of the folding phone 96 while a keypad 104 is associated with a second portion 97. The view B display of the dual view LCD assembly 70 is visible through an exterior window 100 in the device housing. The view A display of the dual view LCD assembly 70 is visible through an interior window 102 in the device housing. When the folding phone 98 is in a folded closed configuration the view A display is obscured but the view B display is exposed.

The folding phone 98 comprises a circuit card 106 which carries driving components 108 which drive the dual view LCD assembly 70 including hardware and software components and power supply conditioning. Because the dual view LCD assembly 70 is one unit, a single set of driving components 108 can power and control the dual view LCD assembly 70. In addition, only one set of connecting circuits needs to be routed through a hinge 110 which connects the two portions of the folding phone 98. The unitary design of the dual view LCD assembly 70 can provide greater structural integrity than two

separate LCDs provide. The dual view LCD assembly is also physically smaller than two separate LCD assemblies would be. The dual view LCD assembly 70 also requires a single mounting structure rather than two which would be required if two separate LCD assemblies were used. All these things together, result in a lighter weight phone 98 which consumes less power.

In the embodiment shown in Figure 5, the view A display is larger and provides more information to the user than the view B display. The view B display can be used to provide such information as the identity of an incoming call, the current state of the battery and the signal strength currently being received or other information of benefit to the user while the folding phone 98 is closed.

In another embodiment, the backlighting on the view A and view B portions are independently controlled by either hardware or software components, for example, in order to reduce the power consumption of the phone. In this way, in the embodiment shown in Figure 5, the view A display need not be back-lit when the phone is closed. In addition, the view B display backlighting may be disabled when the phone is opened, especially, for example, if the information in the view B display is redundant to information available in the view A display. For privacy, the view B display may be blanked when the phone is opened. In one embodiment, view A operates with reflected light and view B operates with artificial light or vise versa.

In one embodiment, the dual view liquid crystal display is manufactured by providing first and second light layers. The first light layer is coupled to a first surface of a plurality of liquid crystal display elements such that the first light layer at least partially covers the first surface. The second light layer is coupled to a second surface of the plurality of liquid crystal display elements such that the second light layer at least partially covers said second surface.

The invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiment is to be considered in all respects only as illustrative and not restrictive and the scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which

come within the meaning and range of equivalency of the claims are to be embraced within their scope.

WHAT IS CLAIMED IS:

CLAIMS

1. A liquid crystal display comprising:

a first light layer;

a plurality of intervening liquid crystal display elements, together defining first and second opposite surfaces, wherein said first surface is adjacent to said first light layer and at least partially covered thereby; and

a second light layer adjacent to and at least partially covering said second surface of said plurality of intervening liquid crystal display elements.

2. The liquid crystal display of Claim 1, wherein said first light layer is at least partially reflective.

3. The liquid crystal display of Claim 1, wherein said first light layer provides artificial light.

4. The liquid crystal display of Claim 1, wherein the liquid crystal display is mounted within a housing such that a first viewing area created by said first light layer is visible through a first window on a first side of said housing and such that a second viewing area created by said second light layer is visible through a second window on a second side of said housing.

5. The liquid crystal display of Claim 1, further comprising a single set of driving components for controlling and powering said liquid crystal display.

6. The liquid crystal display of Claim 1, wherein said plurality of intervening liquid crystal display elements are disposed in layers.

7. A method of manufacturing a dual view liquid crystal display, comprising the steps of:

providing a first light layer;

coupling said first light layer to a first surface of a plurality of liquid crystal display elements such that said first light layer at least partially covers said first surface;

providing a second light layer; and

coupling said second light layer to a second surface of said plurality of liquid crystal display elements such that said second light layer at least partially covers said second surface.

8. The liquid crystal display of Claim 7, wherein said first light layer is reflective.

9. The liquid crystal display of Claim 8, wherein said second light layer provides artificial light.

10. The liquid crystal display of Claim 7, wherein said first light layer provides artificial light.

11. The method of Claim 7, further comprising the step of disposing said first and second light layers and said plurality of liquid crystal display elements within a housing such that a first viewing area created by said first light layer is visible through a first window on a first side of said housing and such that a second viewing area created by said second light layer is visible through a second window on a second side of said housing.

12. A dual view liquid crystal display, comprising:

a first light layer;

means for coupling said first light layer to a first surface of a plurality of liquid crystal display elements such that said first light layer at least partially covers said first surface;

a second light layer; and

means for coupling said second light layer to a second surface of said plurality of liquid crystal display elements such that said second light layer at least partially covers said second surface.

13. The liquid crystal display of Claim 12, wherein said first light layer is at least partially reflective.

14. The liquid crystal display of Claim 12, wherein said first light layer provides artificial light.

15. A device having multiple surfaces, for communication of information to a user, the device comprising:

a dual view liquid crystal display comprising:

a first light layer;

a plurality of intervening liquid crystal display elements, together defining first and second opposite surfaces, wherein said first surface is adjacent to said first light layer and at least partially covered thereby;

a second light layer adjacent to and at least partially covering said second surface of said plurality of intervening liquid crystal display elements; and

a housing mounted to said dual view liquid crystal display having a first viewing area created by said first light layer which is visible through a first window on a first side of said housing and a second viewing area created by said second light layer which is visible through a second window on a second side of said housing.

16. The device of Claim 15, further comprising a circuit card disposed within said housing, said circuit card bearing a single set of driving components for controlling and powering said liquid crystal display.

17. The device of Claim 16, wherein said driving components independently control an amount of light provided by said first and second light layers.

18. The device of Claim 15, wherein said housing defines a folding phone configuration and wherein said first viewing area is obscured when said housing is in a folded closed configuration and wherein said second viewing area is exposed when said housing is in said folded closed configuration.

19. The device of Claim 15, wherein said housing is a telephone housing.

20. The device of Claim 19, wherein said second viewing area is configured to provide caller identification information when an incoming call is received by said device.

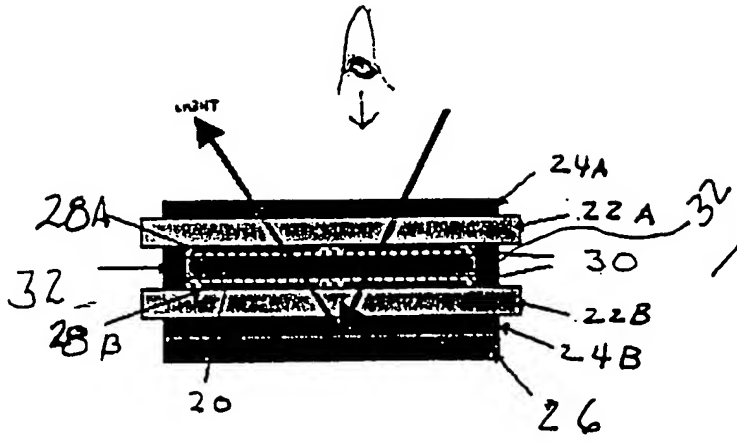

Figure 1

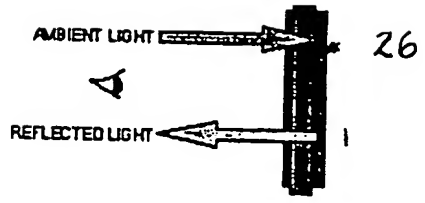

Figure 2A

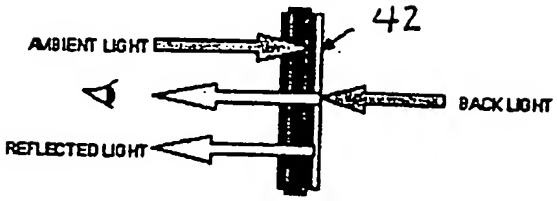

Figure 2B

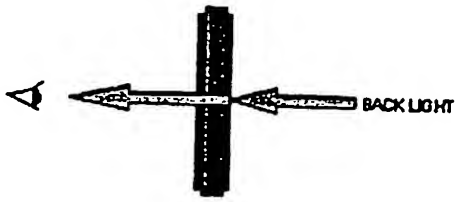

Figure 2C

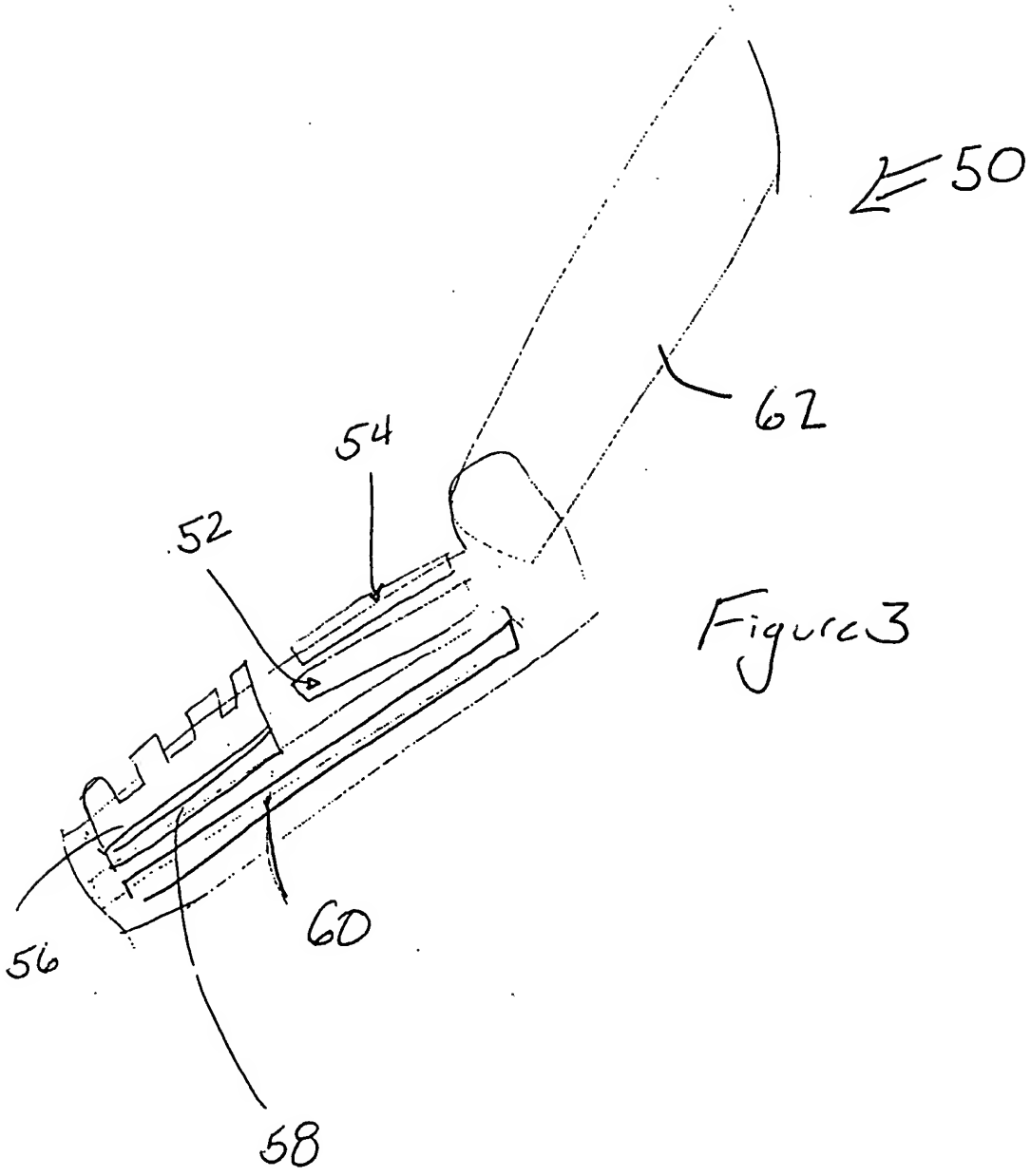

Figure 3

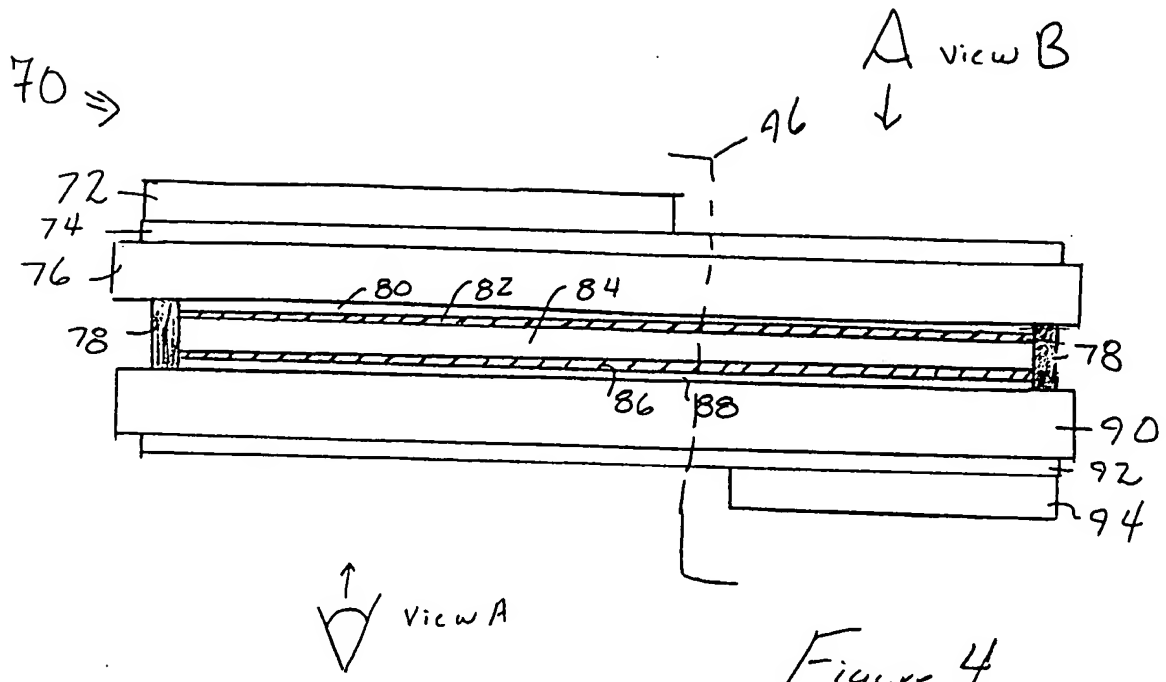

Figure 4

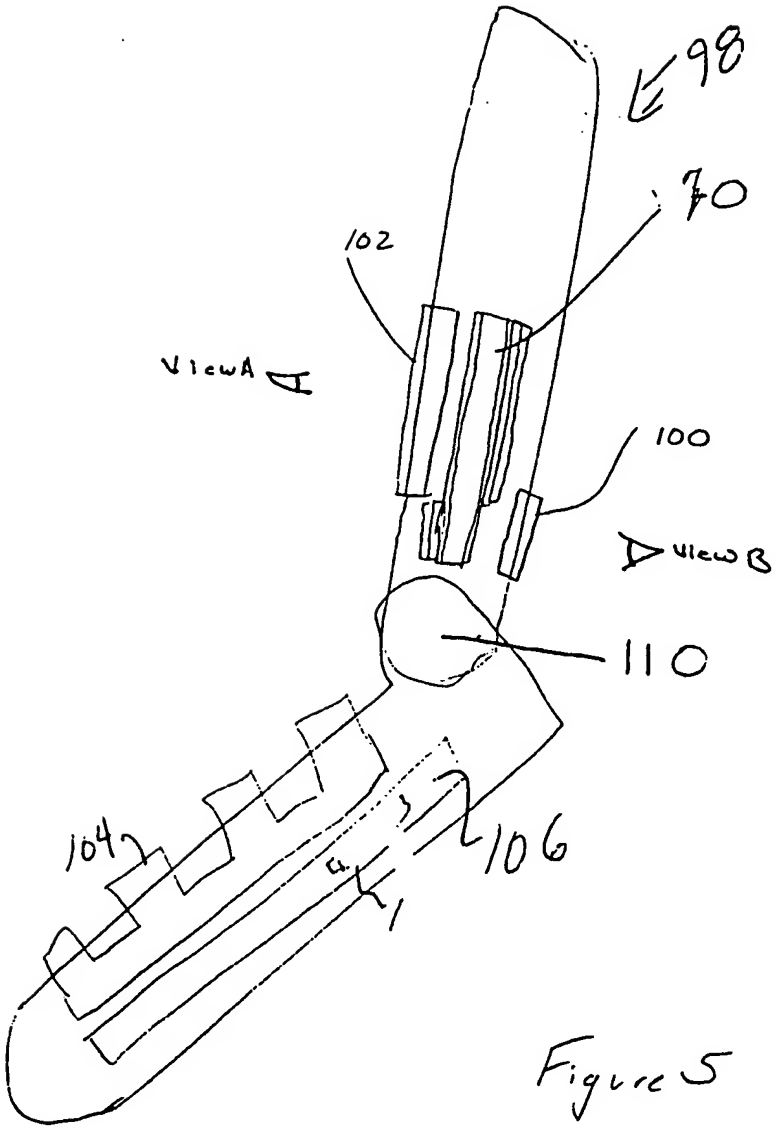

Figure 5

INTERNATIONAL SEARCH REPORT

Inter nal Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G09F9/35 H04M1/02 G02F1/1335

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G02F G09F H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 881 617 A (NOKIA MOBILE PHONES LTD) 2 December 1998 (1998-12-02) abstract; figures 3,5 column 1, line 43 - line 45 column 3, line 31 - line 37 column 4, line 21 - line 27 column 6, line 16 - line 21 column 6, line 43 - line 51	1-20
X	DE 196 25 415 A (SAMSUNG DISPLAY DEVICES CO LTD) 27 March 1997 (1997-03-27) claims 1,2; figure 2	1,3,7,9, 10,12,14

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
14 April 2000	25/04/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Gill, R

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INTERNATIONAL SEARCH REPORT

...formation on patent family members

Inter .nal Application No
PCT/US 99/29918

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